

# **Using STELLA for Water Resources Decision Support**

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Dan Rodrigo  
CDM



## **Overview of Simulation Models**

- ◆ There are many types of simulation models that are used for California water planning:
  - ◆ CALSIM
  - ◆ HEC
  - ◆ H20Net (hydraulic)
  - ◆ MODFLOW (groundwater)
- ◆ These models are usually called single-purpose models, in that they simulate only one thing (e.g., surface deliveries and allocations)
- ◆ These models are usually very detailed and take hours to run

## Different Kind of Simulation Models

- ◆ More and more, there is a need for comprehensive simulation of many different kinds of systems
- ◆ Decisions that are being made need to reflect not only the physical delivery of water, but where that water comes from, how much does it cost, what is the resulting water quality, and what impact does the water development and use have on the environment
- ◆ This blending of the physical and social systems requires an integrated simulation model

## Two leading integrated systems models

- ◆ STELLA
- ◆ EXTEND
  - ◆ Both use object-oriented programming and have built-in graphical interfaces and output
  - ◆ Both can be customized to simulate any type of system or systems (e.g., physical, environmental, financial, water delivery)
  - ◆ Both have the ability to show results in graphical form during live simulations
  - ◆ Both are geared to running complex simulations in relatively short time (seconds and minutes)

## Principles of Integrated Simulation Models

- ◆ Dynamic response to change
- ◆ Simultaneous interaction of many different types of systems (physical, biological, social)
- ◆ Approximation of more detailed models (using rule curves or heuristic relationships)
- ◆ Graphical display of real-time simulation
- ◆ Quick run-time of simulation (seconds and minutes)
- ◆ Geared towards strategic or policy level decision-making

## Non-Integrated vs. Integrated Systems



Non-Integrated: Many different types of simulation models, running independent of each other with no simultaneous cause-and-effect relationships

Integrated: Many different types of systems simultaneously interacting with each other in real-time in one system model; often called holistic planning

## Where is this approach being used?

- ◆ San Diego Water Resources Plan (STELLA)
  - ◆ Water supply integrated plan
  - ◆ Multiple objectives (reliability, cost, quality, environment, risk)
- ◆ LA Integrated Resources Plan (STELLA)
  - ◆ Watershed plan, blending water supply, wastewater, and stormwater planning
- ◆ Santa Clara Valley Water District IRP (EXTEND)
  - ◆ Water supply integrated plan
  - ◆ Multiple objectives (reliability, cost, quality, environment, risk)
- ◆ Ipswich River Basin (STELLA)
  - ◆ River diversions and impacts
  - ◆ Used for regulatory negotiations and policy

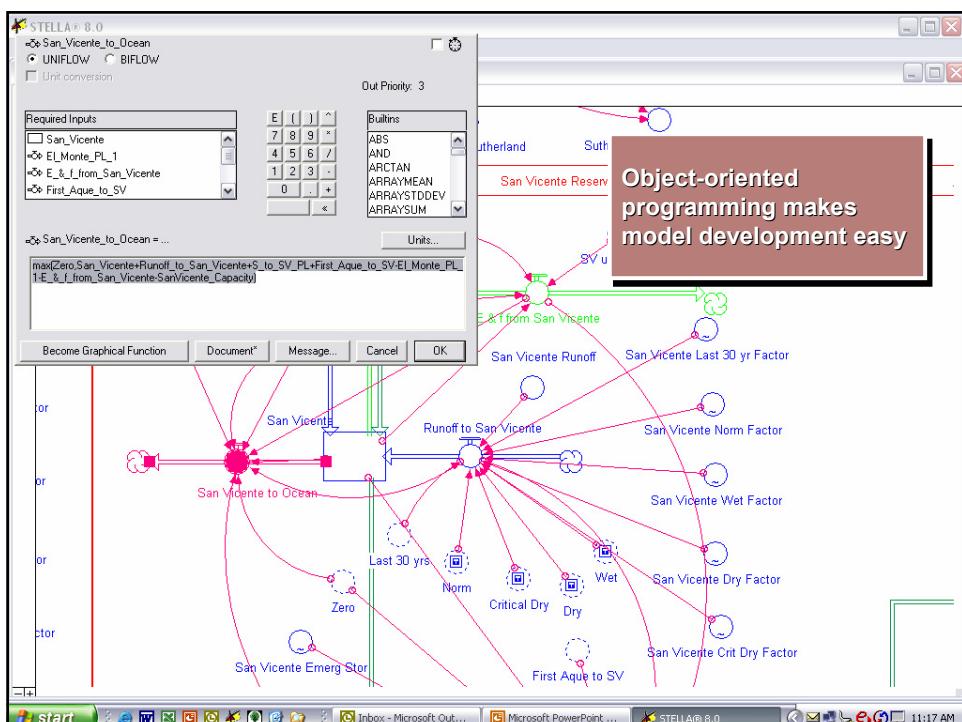
## Overview of STELLA

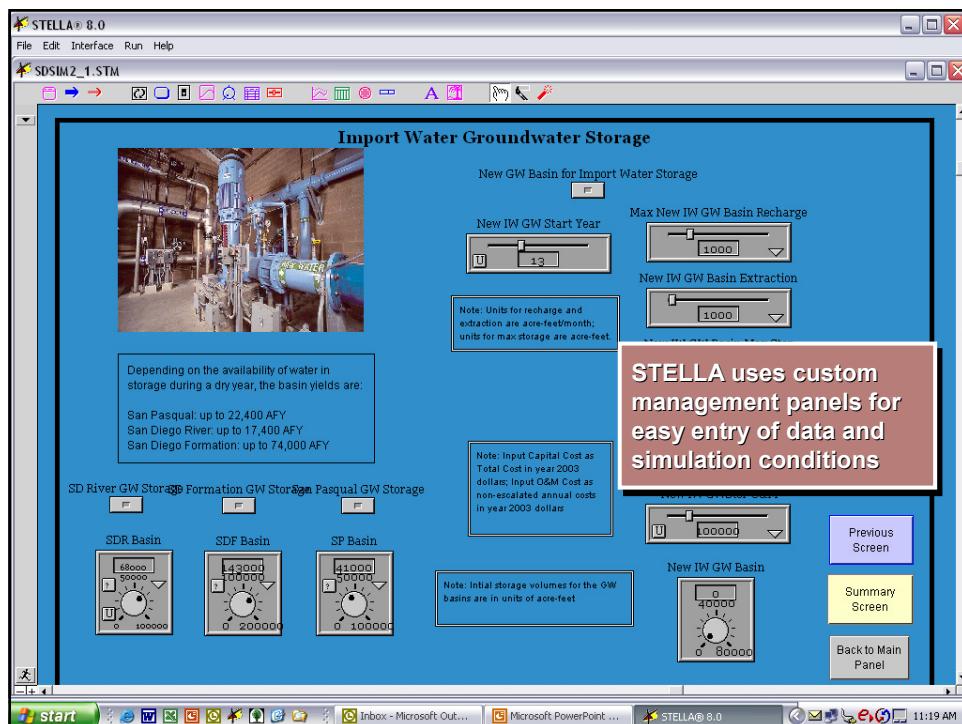
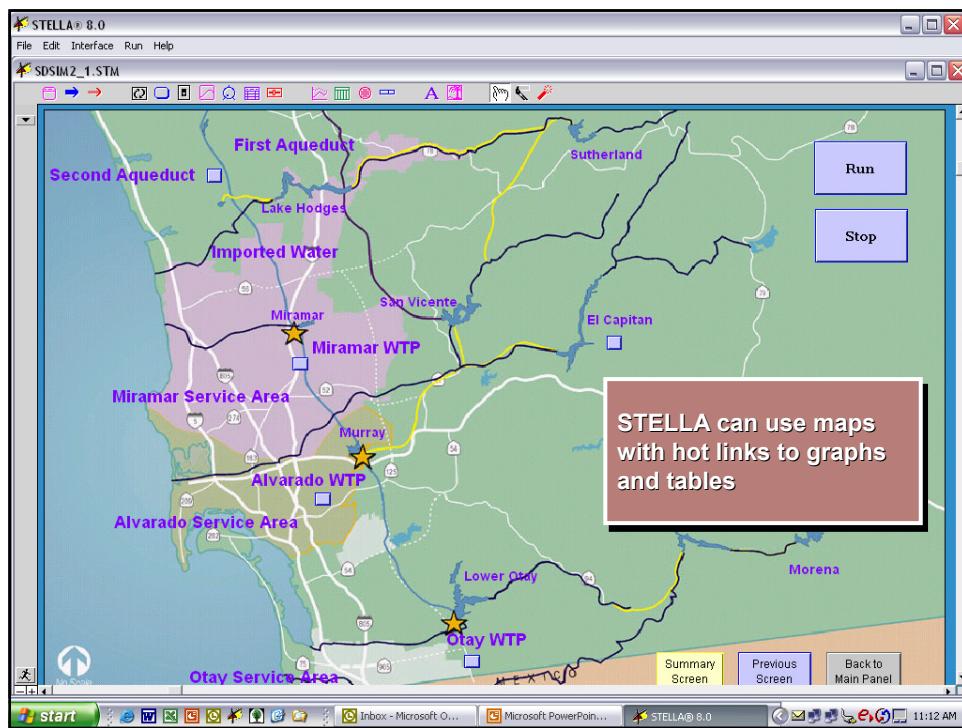
- ◆ STELLA is an object-oriented programming environment
- ◆ It simulates any kind of system using interactive graphics
- ◆ It models systems using four simple entities
  - ◆ Stocks: things that accumulate
  - ◆ Flows: rates that flow into or out of stocks
  - ◆ Converters and connectors: mathematical relationships between stocks and flows
- ◆ It can model over 32,000 model entities

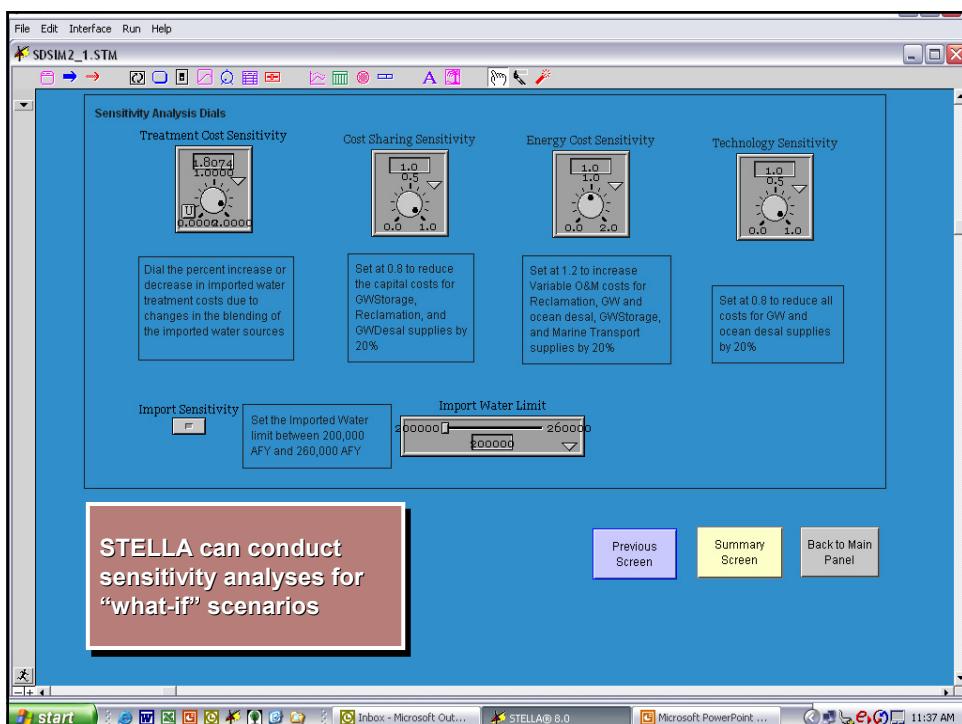
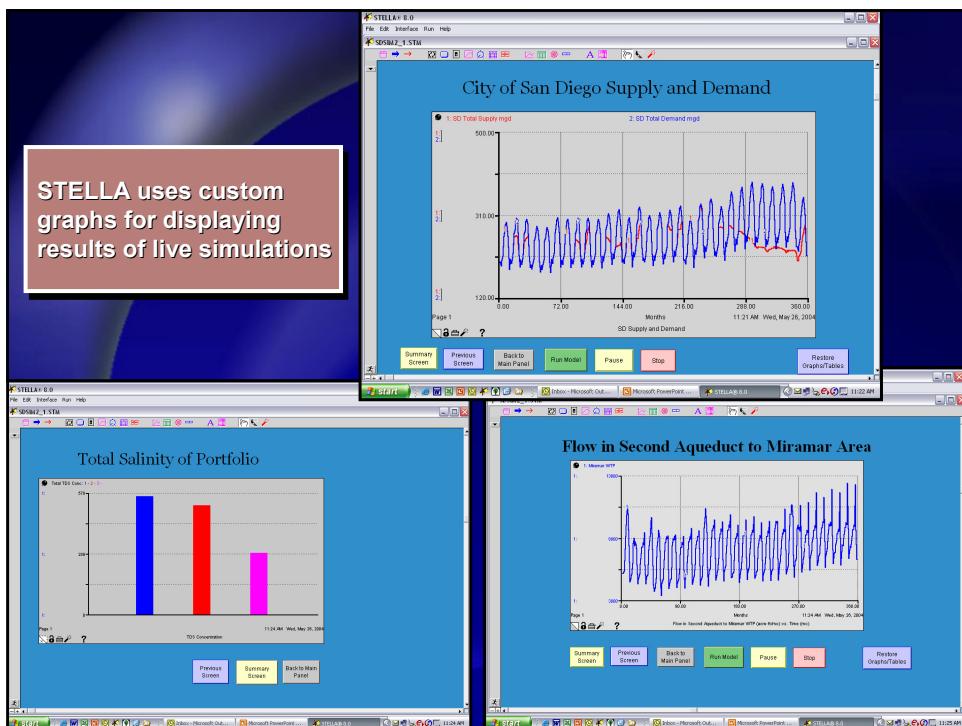
## Overview of STELLA

- ◆ STELLA has three levels:

- ◆ Management panel: graphical environment for inputs, selection of simulations, and output graphics and sensitivity analyses
- ◆ Model construction: using object-oriented programming, a system is created
- ◆ Program code: STELLA software converts object-oriented model into mathematical code for easy debugging







## **Application to City of San Diego**

- ◆ City of San Diego is over 90% dependent on imported water from northern California and Colorado River
- ◆ Imported water subject to extreme variability due to droughts and wet periods, and environmental restrictions
- ◆ City had many different types of opportunities to explore (groundwater, conservation, recycling, desalination, transfers)

## **Application to City of San Diego**

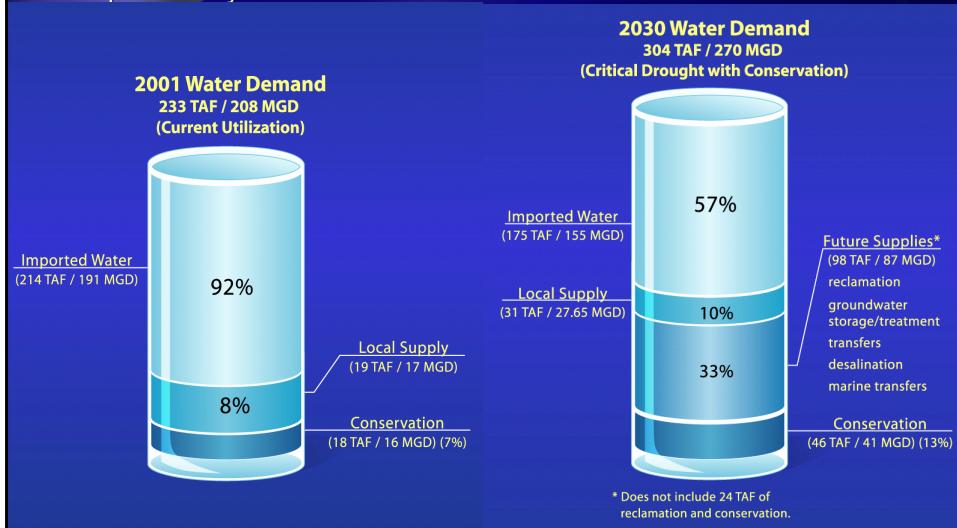
- ◆ STELLA was used as a water resources planning tool to help build alternatives to meet multiple stakeholder objectives such as:
  - ◆ Improve reliability
  - ◆ Protect water quality
  - ◆ Provide environmental sustainability
  - ◆ Manage costs
  - ◆ Minimize risks

## Application to City of San Diego

- ◆ STELLA was able to show the City and its public stakeholders how these alternatives performed using the objectives as criteria
- ◆ City and stakeholders could easily see trade-offs
- ◆ City and stakeholders identified sensitivity analyses for staging investments (adaptive management)

## Application to City of San Diego

- ◆ City and Stakeholders arrived at a balanced plan that can take the City from being 90% dependant on imported water to just under 60% dependant by 2030.



## Conclusions

- ◆ STELLA and other tools, such as EXTEND, can be powerful additions to more detailed simulation models
- ◆ STELLA is not intended to replace other models, but rather compliment them
- ◆ STELLA can be used to quickly demonstrate key interrelationships between water delivery systems, the environment, and economics
- ◆ STELLA has been successfully used for preparation of Integrated Resources Plans, policy negotiations and stakeholder decision-making